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TANGANYIKA

Annual Report

of the

Department of Agriculture

1958

PART II

(Research)

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Annual Report

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Department of Agriculture

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PART II

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TANGANYIKA

ANNUAL REPORT OF THE DEPARTMENT OF AGRICULTURE, 1958

Part II

INTRODUCTION

Part II of the Annual Report of the Agricultural Department is presented this year as a more general report on the activities of its Research Division rather than reports by specialists for specialists as has been customary. More detailed information will be made available on application to the officers in charge of the research stations.

The building programme financed by a grant from Colonial Development and Welfare funds is almost complete. The new laboratories and houses at Ukiriguru for the Western Regional Research Centre should be completed by the end of 1959. His Excellency the Governor opened the new laboratories at the Northern Regional Research Centre in September.

During the year responsibility for pasture research work passed from the Veterinary Department to the Agricultural Department. One Pasture Research Officer was transferred from the Veterinary Research Laboratory, Mpwapwa, to Ilonga, the other officer remained on his station at Tengeru. A second Agricultural Chemist arrived in November and was posted to Nachingwea in the first instance to work with the Agricultural Chemist stationed there. An Experimental Officer was posted to the Research Centre, Tengeru, as an assistant to the Plant Pathologist.

The most important general line of research being followed is that of maintaining and improving crop production by means of animal manure, artificial fertilizers, fallows, intercropping and crop succession. In a number of areas useful results have been obtained from formal experiments and it is now possible to give thought to the next stage, that of building the results into a number of simple farming systems for trial. This will make possible the study of factors that are not considered in statistical field experiments but are vital in assessing the value of a farming system. Such factors are the speed at which land can be cultivated and planted, problems of weeding, etc., according to whether ox or hoe cultivation is used. These trial farms should yield very valuable information so long as they are adequately documented.

Work on intercropping was continued at Mwanhala and Ilonga. At Mwanhala where the rainfall was low and badly distributed, intercropping still gave better production per acre than pure stands. At Ilonga rainfall was more favourable, again better production was achieved by intercropping and it was found that weeds left in the row reduced maize yields to the same extent as a reasonable crop of groundnuts.

Experimental work on irrigated crops is proceeding slowly owing to lack of technical experience. Results to date have emphasized the necessity for early planting of crops under irrigation whereas it might have been expected that under favourable soil moisture conditions the planting period could be considerably extended. It is possible that work will also be required to produce higher yielding varieties than are at present available.

To date very little work has been done on cashew, a crop worth about £1 million pounds to the Territory. A collection of varieties from the principal cashew growing countries has been assembled at Nachingwea. It is hoped that increasing attention can be given to research on this valuable crop. Castor bean worth some £800,000 per annum has received attention during the past two years. It had been hoped that the insecticidal methods worked out for controlling cotton pests would have been satisfactory for castor pests. Unfortunately this has not proved to be the case. Until suitable methods of control have been worked out, Giant varieties that are not so susceptible to insect damage must be relied on in most areas.

Valuable research work on cotton continues in Lake and Eastern Provinces. It has been found that there is an increased resistance to bacterial blight in the UK series of varieties. A large scale trial with a mercurial seed dressing instead of Perecot has been planned. Fifty tons of UK 55 have been treated with Abavit B and it will be possible to make an assessment of the control of bacterial blight during the coming season. Cotton production under irrigation is very promising at the Tanganyika Agricultural Corporation Trial Farm, Rujewa, in the Southern Highlands Province and also shows promise for other irrigation schemes.

A very large collection of wheat varieties has been tested for rust resistance in the Northern Province. Most of these have had to be discarded. Owing to the rapidity with which the rust can produce new races to infect new wheat varieties this work resolves itself into an attempt to keep just ahead of the rust rather than to achieve a final solution.

Staff from the Research Division are also seconded to serve on Commodity Research Stations, financed by the industry concerned, as listed below. Separate Annual Reports are published by the financing bodies. The Chief Research Officer helps to plan the experimental programme on the Irrigation Trial Farms run by the Tanganyika Agricultural Corporation in connection with the Rufiji Basin Survey.

STAFF—RESEARCH DIVISION

(as at 31st December, 1958)

Headquarters

Chief Research Officer: A. C. Evans, B.Sc. (Bristol), D.I.C., Ph.D. (London).
Agricultural Officer: D. J. Turner, B.Sc. (Agric.) (Reading), Ph.D. (Edinburgh).
Assistant Agricultural Officer: A. Sreedharan, B.Sc. (Travancore).
Research Assistant: Mrs. I. C. Walker.

Central Region

Research Centre, Ilonga (P.O. Box 6, Kilosa):

Pasture Research Officer (Acting Senior Research Officer): J. J. van Rensburg, M.Sc. (Witwatersrand).

Plant Breeder: M. J. Cole, B.Sc. (Southampton), Ph.D. (London).

Plant Breeder: R. Smith, B.Sc. (Manchester) (seconded from Empire Cotton Growing Corporation).

Entomologist: E. W. Valentine, B.Agric.Sc. (New Zealand) (seconded from Empire Cotton Growing Corporation).

Agricultural Officer (Experiments): A. M. MacDonald, B.Sc. (Agric.) (Aberdeen), D.T.A. (Trinidad).

Farm Manager: J. R. Tile.

Coast Experimental Station, Chambezi:

Field Officer (Agriculture): B. Minto, C.D.A.

Mbozi Sub-station: (P.O. Mbozi):

Senior Field Officer (Agriculture): J. I. Thompson.

NORTHERN REGION

Research Centre, Tengeru (P.O. Box 302, Arusha):

Agricultural Officer (Acting Senior Research Officer): D. V. Chambers, B.Sc. (Agric.) (Dunelm).
Entomologist: G. Swaine, B.Sc. (Sheffield).
Plant Breeder: B. G. Houston, B.Sc. (Agric.) (Aberdeen), Dip. Agric. Sc. (Cambridge), D.T.A. (Trinidad).
Plant Pathologist: E. A. Riley, B.Sc. (Cape), D.I.C., Ph.D. (London).
Pasture Research Officer: T. O. Robson, B.Sc. (Witwatersrand).
Experimental Officer (Plant Pathology): B. Simon, B.Sc. (Makerere).
Farm Manager: D. C. Randall.

SOUTHERN REGION

Research Centre, Nachingwea (P.O. Box 43, Nachingwea):

Agricultural Officer (Acting Senior Research Officer): F. M. Spencer, B.Sc. (Hort.) (Reading).
Plant Breeder: A. K. Auckland, B.Sc. (Dunelm), Dip. Agric. Sc. (Cambridge), D.T.A. (Trinidad).
Entomologist: M. Bigger, B.A. (Trinity College, Dublin), D.T.A. (Trinidad).
Agricultural Chemist: B. Anderson, M.Sc. (Agric.) (Reading).
Agricultural Chemist: G. D. Anderson, M.Sc. (Agric.) (Dunelm), Ph.D. (Dunelm).
Plant Pathologist: P. K. S. Clinton, B.Sc. (Sheffield).
Agricultural Officer (Experiments): T. W. J. Smethurst, B.A. (Oxford), D.T.A. (Trinidad).
Experimental Officer (Plant breeding): G. A. Semiti, B.Sc. (Makerere).
Farm Manager: M. J. Simmonds.

Mtopwa Sub-station:

Assistant Agricultural Officer: K. J. Rwiza, Dip. Agric. (Makerere).

WESTERN REGION

Research Centre, Ukiriguru (Private Bag, Fela):

Chief Scientific Officer: J. E. Peat, C.B.E., B.Sc. (Edinburgh), A.I.C.T.A.
Plant Breeder: M. H. Arnold, B.A. (Cambridge).
Plant Breeder: K. J. Brown, B.Sc. (Reading).
Experimental Officer (Chemist): A. M. Kabaara, B.Sc. (Makerere).
Plant Pathologist (Temporary): Mrs. M. H. Arnold, M.A., Ph.D. (Cambridge).
(The above officers are seconded from Empire Cotton Growing Corporation).
Entomologist: I. A. D. Robertson, B.Sc. (Aberdeen).
Agricultural Officer (Pasture Research): G. D. Scott, B.Sc. (Witwatersrand).
Agricultural Officer (Experiments): B. Walker, B.Sc. (Agric.).
Farm Manager: W. J. H. Le Bechee.

Experimental Station, Mwanhala:

Agricultural Officer: D. B. Scott, B.Sc. (Agric.) (Dunelm), D.T.A. (Trinidad).

Experimental Station, Urambo.

Agricultural Officer: T. F. O'Callaghan, B.Agr.Sc. (National University, Ireland).

COMMODITY STATIONS

(Staff Secondment)

Sisal Research Station, Mlingano (P.O. Ngomeni).

(Financed by Tanganyika Sisal Growers' Association)

Senior Research Officer: G. W. Lock, O.B.E., N.D.A., N.P.P., C.D.A., A.I.C.T.A.
Plant Physiologist: E. C. Diekmahns, B.Sc. (Glasgow), Dip.Agric.Sc. (Cambridge).
Agricultural Officer: I. Constantinesco, B.Sc. (Agric.) (Reading), N.D.Agric.Eng.
Farm Manager: R. Simpson.

Coffee Research Station, Lyamungu (P.O. Moshi):

(Financed by Tanganyika Coffee Board)

Senior Research Officer: F. R. Sanders, B.A. (Cambridge) Dip. Agric. (Cambridge).
Entomologist: R. G. Tapley, B.Sc. (London).
Agricultural Officer: A. J. M. Gunn, B.Sc. (Aberdeen).
Horticulturist: L. M. Fernie.
Farm Manager: M. Jenner.

Tobacco Research Station, Iringa (P.O. Box 182, Iringa):
Agricultural Officer: B. C. Akehurst, M.B.E., B.Sc. (Agric.) (Reading).

Pasture Research Station, Kongwa (P.O. Kongwa):

(Financed by Tanganyika Agricultural Corporation)

Agricultural Officer: M. A. Owen, B.Sc. (Agric.) (Wales) Dip.Agric. (Reading), D.T.A. (Trinidad).

Experimental Station (Coffee) Maruku (P.O. Box 127, Bukoba):

(Financed by Tanganyika Coffee Board)

Agricultural Officer: H. W. Mitchell, B.Sc. (Agric.) (London), D.T.A. (Trinidad).
Farm Manager: S. D. Pyman.

SOIL FERTILITY

Perhaps the most important aspect of the research programme is that dealing with the maintenance and improvement of soil fertility. Unless soil fertility is maintained the efforts of our plant breeders, plant pathologists and entomologists to increase yields will be of little value.

The fact must be faced that only a very small proportion of our farmers can afford artificial fertilizers, mainly those growing high value cash crops. Thus, the great majority of farmers must rely on methods that will transport "fertility" from one area to another, and so increase productivity per unit of labour. This can only be done in stock raising areas where cattle, mainly, can transport fertility in the form of an end-product, manure.

In areas where stock cannot be kept because of disease some form of fallowing can be used. But, it would appear that some reasonable degree of soil fertility must be present before this method is feasible. At Mwanhala, Nzega District, the growth of grass and legumes, after three years of natural fallow is so poor that the failure of a three-year fallow to produce any measurable increase in yield over continuous cultivation is understandable.

At Ukiriguru, on the Hill Sand soil type, even a one years natural fallow will produce an increase in yield compared with continuous cultivation.

A considerable amount of work has been done on green manuring but improvements in yield have rarely been shown and when they have occurred the increase is not commensurate with the effort required to grow the green manure.

A study of the valuable work carried out over many years at Ukiriguru on the value of fallows on the Hill Sand soil is incomplete as yet but the results suggest that fallowing has not increased production compared with continuous cultivation but rather that, over a cropping cycle, the same total production has been achieved. The great difference between the two methods is that in the fallow system less work has been required to produce similar amounts of crop.

At present emphasis in research on soil fertility is given to experiments on the value of manure and fertilizers as it is considered that quicker and larger economic gains can be obtained from these than from experiments on fallow.

A selection of the results obtained at Ukiriguru are given in Table 30. Residual responses to farmyard manure applied in the previous year and also three years previously are very appreciable, 654 and 526 lb. of seed cotton per acre. Residual responses to phosphate applied at the same time are also very appreciable, 327 and 538 lb. of seed cotton per acre, in the presence of a nitrogenous fertilizer. These responses are of the same order as that obtained from an application of phosphate and nitrogen in 1958, 517 lb. of seed cotton per acre. An application of gypsum (containing readily available calcium) did not give any increase in yield whether applied by itself or in combination with other fertilizers.

Work has been started at Ukiriguru by an officer of the Empire Cotton Growing Corporation to study the effect of various manurial and fertilizer treatments on the chemical status of various elements in the soil. In Trial 26 phosphate, as estimated by the Truog method, has increased appreciably in the top 12 inches of the profile when farmyard manure has been applied. Where farmyard manure has not been applied phosphate is higher below 42 inches. These results are averaged over all other treatments. Farmyard manure has increased the total exchangeable cations in the soil but potassium values have only been increased in the top 12 inches.

Sulphate of ammonia applied at 200 lb. per acre per annum for the four years preceding sampling has reduced the total exchangeable cations in the top 12 inches but there is some accumulation below 42 inches. The application of this fertilizer has reduced soil pH at all depths sampled, to 66 inches. In the top 6 inches the pH has been reduced from 6·42 to 5·44.

Studies on changes in soil nitrate-nitrogen content are in progress. It has been found that when sulphate of ammonia is applied the amount of nitrate nitrogen below 24 inches tends to be lower on plots receiving phosphate. This may be due to a greater uptake of nitrate by the larger plants growing on the plots receiving phosphate.

Analyses of manure from African cattle bomas and farymyard manure prepared at Ukiriguru have yielded interesting results.

	Per Cent of Air Dry Material			
	Organic Matter	N	P_2O_5	K_2O
Boma Manure	28·8	·68	1·04	4·00
Farmyard Manure, Ukiriguru	19·5	·66	·63	2·23
Farmyard Manure, Nachingwea	35·0	1·46	·23	2·64
Farmyard Manure, England	60·6	2·66	2·67	2·50

Both the boma manure and Ukiriguru farmyard manure contain considerably less organic matter, nitrogen and phosphate than average quality farmyard manure in England. Their potash contents are however as good or better.

At the Southern Regional Research Centre, Nachingwea, a new experimental farm has been started. This farm was originally opened up as a Tanganyika Agricultural Corporation production farm, in 1950-52, and so after a number of years production the land is in a suitable condition for research on soil fertility.

Work carried out by the Tanganyika Agricultural Corporation has shown that the application to maize of 1 cwt. each of single superphosphate and sulphate of ammonia gives a high return. Higher rates of application of sulphate of ammonia and phosphate were tested.

TABLE 1

The Effect of High Rates of Application of Sulphate of Ammonia and Superphosphate on Maize Yields

Lb. per Acre

Superphosphate	Sulphate of Ammonia lb. per acre				
lb. per acre	100	200	300	400	Mean
100 ...	1,708	2,087	2,175	2,511	2,120
200 ...	1,883	2,175	2,000	2,234	2,073
300 ...	2,146	2,175	2,671	2,321	2,328
Mean ...	1,912	2,146	2,282	2,355	2,174

Taking the cost of sulphate of ammonia at 31/- per 100 lb. and of maize at 17 cents per lb. a response of 160 lb. of maize per acre is necessary to pay for the fertilizer. The results obtained suggest that applications greater than 200 lb. of sulphate of ammonia per acre are not likely to be economic.

Complaints have been made that the groundnut variety Asiriya Mwitunde produces a large number of "pops" i.e. fully developed husks but undeveloped or poorly developed kernels. An experiment was planted to test the effect of burnt lime, single-superphosphate and double-superphosphate at close and wide plant spacings in the row. Work in America had shown that lack of calcium causes pops and the Nachingwea soils have a low calcium content as shown by chemical analysis. The experiment was sited in an area known to be low in calcium. Lime had no effect at all on yield. The single superphosphate increased yield from 951 lb. to 1,028 lb. per acre but double-superphosphate did not increase the yield. It is considered that pops in this variety are characteristic of the variety which is a long season one. Partially developed pods will produce pops when the available soil moisture is low or the temperature drops to a low level.

On the experimental farm are patches of soil, sometimes of 2-3 acres, on which maize grows very poorly, plants are yellow and stunted and yields low. Soil analysis showed a particularly low level of calcium and a low soil pH. Applications of burnt lime were tested using groundnuts and maize as indicator crops to see if the condition could be remedied.

TABLE 2

EFFECT OF HEAVY LIME DRESSINGS ON GROUNDNUTS AND MAIZE

LB PER ACRE

Lime Rate	Maize	Groundnuts
None	173	1,021
1 ton per acre	41	1,023
2 tons per acre	51	1,077
3 tons per acre	69	977

The application of lime reduced a poor maize yield to a miserable yield. Groundnuts yielded well. Thus it appears that a low calcium level in the soil is not the cause of low maize yields. An alternative explanation is being sought by means of leaf analysis and further soil analyses. It is possible that a peculiar toxic condition occurs in these patches to which maize is very susceptible but which has no effect on groundnuts.

Little work has been done at Nachingwea to date on the value of farmyard manure in view of the very low cattle population of the area. Interest in cattle however is now very evident and it is considered important that figures should be obtained to show the value of farmyard manure as part of the economic pattern of animal husbandry. The results from four experiments set up to study the technique of comparing farming systems incorporating farmyard manure and fertilizers are given below.

TABLE 3

EFFECTS OF FARMYARD MANURE AND FERTILIZERS ON A RANGE OF CROPS

LB. PER ACRE

	Farmyard Manure		
	None	3 tons	6 tons
Sorghum (Msumbiji)	370	850	1,094
Maize (Improved Katambili)	1,048	1,074	1,228
Sesame (Local)	132	151	206
Groundnuts	1,190	1,176	1,181
Soya bean...	511	598	626
Fiwi bean...	84	72	94
Cowpea	101	240	134

	Fertilizers	
	None	100 lb. of single superphosphate
Sesame	62	62
Groundnuts	1,102	1,433
Soya bean...	314	387
Fiwi bean	50	74

	None	100 lb. of single superphosphate: 100 lb. of sulphate of ammonia	100 lb. of single superphosphate: 200 lb. of sulphate of ammonia
Sorghum	379	511	413
Maize	827	995	1,195

Of all the crops grown only groundnuts gave a good yield, they also gave a high response to superphosphate but not to farmyard manure. Tall local sorghum gave increased yields in the presence of farmyard manure but not of phosphate and nitrogen. Maize showed but little response to either farmyard manure or fertilizers. The other crops which were planted later gave very poor yields due to the low rainfall in April and May.

The results are given in some detail although responses to treatments are generally poor as this is the first year in a study of the build up of soil fertility by means of fertilizers, farmyard manure and a planted fallow. No results are available for the latter treatment this year.

in another experiment, designed to study whether farmyard manure gives increased yields only through the plant nutrients contained in it or through the incorporation of organic matter in the soil in addition, good responses were obtained to 3 tons of farmyard manure and to the ash from an equal amount of manure. The responses to both types of dressing were very similar.

TABLE 4

EFFECT OF FARMYARD MANURE AND AN EQUIVALENT AMOUNT OF ASH PLUS NITROGEN ON YIELDS OF GROUNDNUTS AND MAIZE
LB. PER ACRE

	Control	Farmyard Manure	Ash
Maize	1,421	1,843	1,941
Groundnuts	931	1,062	1,037

Several years must elapse before any effects from any increase in soil organic matter can be shown if such an increase does occur.

At Mwanhala, Nzega District, a number of permanent experiments have been started to test the value of farmyard manure and fertilizers on a number of crops. These are in their first or second year only. The outstanding results so far are that both manure and fertilizers usually give appreciable increases in yield but the increase is greater from fertilizers. The following table summarises the results.

TABLE 5

INFLUENCE OF MANURE AND FERTILIZERS ON YIELDS IN TWO EXPERIMENTS—LB. PER ACRE

	Maize			Groundnuts		
Treatments	1957A	1958A	1958B	1957A	1958A	1958B
None	1,566	541	947	872	445	257
3 tons of manure	1,958	1,040	1,142	1,039	430	364
Fertilizer	2,390	1,727	1,351	1,112	641	458

Fertilizer application, 120 lb. of double superphosphate (Shs. 48/-) per acre with 120 lb of sulphate of ammonia (Shs. 36/-) in addition for maize.

These experiments have been undertaken to study the build up of soil productivity by means of manure and fertilizer over a number of years since it has been found that fallowing the land for three years does not increase productivity.

In another experiment the residual value of phosphate and manure applied to groundnuts in 1957 was measured by growing maize in 1958. It was found that both treatments gave valuable residual effects.

	YIELDS, LB. PER ACRE	
	1957	1958
Treatments 1957	Groundnuts	Maize
None	758	368
3 tons manure	887	631
100 lb. superphosphate	1,041	773
200 lb. superphosphate	1,155	1,229

A top-dressing of 120 lb. per acre of sulphate of ammonia was given to the maize in 1958.

	Cost in Shs.	Returns in Shs. per Acre		
		Groundnuts	Maize	Total Profit
3 tons manure	... (labour) ...	52/- ...	51/- ...	67/-
100 lb. superphosphate	... 40/- ...	113/- ...	69/- ...	106/-
200 lb. superphosphate	... 80/- ...	159/- ...	146/- ...	189/-
120 lb. sulphate of ammonia	... 36/-			
Groundnuts	... 40cts./lb.			
Maize	... 17cts./lb.			

Fertilizers and manure applied in 1957 gave further appreciable increases in 1958 and again the increases from fertilizers were larger than those from manure. An estimate has been made of the financial returns from these treatments. From both rates of superphosphate the profit is approximately 150 per cent on the cash outlay. In the case of manure it has been assumed that the manure was available without cost. No estimate can be made of its cost if it had to be bought.

Only in one soil fertility experiment is there a comparison of cropping in pure stands and intercropping in relation to improving production by means of manure and fertilizer.

TABLE 6

EFFECT OF INCROPPING ON RESPONSES OF MAIZE AND GROUNDNUTS TO MANURES AND FERTILIZERS, MWANHALA—LB. PER ACRE

	Intercropping				Pure Stand			
	1 acre				Two ½ Acres			
	Nil	Responses to			Nil	Responses to		
		Manure	Fertilizer	Both		Manure	Fertilizer	Both
Maize	466	143	312	643	473	98	202	262
Groundnuts ...	299	12	31	2	129	53	101	109

In pure stands both maize and groundnuts give appreciable responses to manure and fertilizers both alone and applied together. When intercropped only maize gives responses, bu there is no reduction in the yield of groundnuts. There is still an overall improvement int production as a result of intercropping.

Experiments on other crops have also shown useful increases in yields as a result of applying fertilizers.

At Maruku Coffee Research Station, Bukoba District, the soil is mainly a poor leached sand, Rweya soil type. A number of experiments were carried out in the early years of the station to try to improve productivity. These suffered various vicissitudes, but sufficient reliable data was obtained to plan further work based on the application of farmyard manure, sulphate of ammonia, potash, phosphate and lime. An unexpected result was the continued residual effect of certain treatments.

Artificial fertilizers were applied to plots treated with 10, 5 or nil tons of farmyard manure. The combinations of fertilizers used were; complete; all combinations of three; nil. Maize was grown in the first year. Theft of cobs rendered yield results useless and stover weight had to be used to estimate the value of treatments. The results clearly showed the value of farmyard manure, nitrogen and lime. When this combination was present the highest yields were obtained from a treatment. Maize was again planted in 1958 and reliable yield figures obtained. Sulphate of ammonia only was reapplied.

TABLE 7

YIELDS OF MAIZE OBTAINED FROM COMBINATIONS OF FARMYARD MANURE AND VARIOUS COMBINATIONS OF ARTIFICIAL FERTILIZERS AND LIME

	Nil	Five Tons FYM	Ten Tons FYM
NPKL	1,838	2,253	2,253
PKL	850	1,015	1,260
NKL	1,958	2,405	2,500
NPL	988	1,905	2,593
NPK	1,405	2,110	2,445
Nil	450	870	1,165

N=2 cwt. of sulphate of ammonia ... ... Costing Shs. 70
P=2 cwt. of superphosphate ... ... Costing Shs. 86
K=1 cwt. of muriate of potash ... ... Costing Shs. 36
L=20 cwt. of lime ... ... Costing Shs. 222

Farmyard manure alone and all combinations of fertilizers gave appreciable increases in yield. Highest yields were however obtained from combinations of farmyard manure and fertilizers. Yields were lowest when sulphate of ammonia was not applied. This year the absence of lime did not cause any reduction in yield in the presence of farmyard manure. At the ten-ton level of farmyard manure the absence of potash caused no reduction in yield but at the five-ton level its absence appears to have reduced the yield by a small amount. The results obtained from the establishment of coffee experiment are in conformity with the general results of this experiment.

At Maruku the results for two years of a study of the effect of sulphate of ammonia, phosphate, potash and lime on the local grazing are available. Three degrees of intensity of cutting were also included.

The greatest production of dry matter was obtained by only taking two cuts a year. The grass produced however was very stemmy and more suitable for coffee mulching than for feeding stock. It is interesting to note in this respect that in Kenya coffee growers are advised to apply fertilizers to grass grown for mulching rather than directly to the coffee tree. The results from plots treated with sulphate of ammonia are given below.

TABLE 8

DRY GRASS PRODUCTION—LB. PER ACRE

No. of Cuts	1957	1958	Total
6	6,589 ...	5,470 ...	12,059
4	7,117 ...	7,025 ...	14,142
2	9,706 ...	10,215 ...	19,921

As the number of cuts increases the production decreases.

The greatest response obtained has been to sulphate of ammonia particularly when taking only two cuts per annum.

TABLE 9

RESPONSE OF GRASS TO FOUR LEVELS OF APPLICATION OF SULPHATE OF AMMONIA AT 2, 4 AND 6 CUTS A YEAR LB. OF DRIED GRASS PER ACRE FOR TWO YEARS

No. of Cuts	Nil	1 cwt.	2 cwt.	4 cwt.
2 ...	14,022	19,666	21,482	24,412
4 ...	11,372	14,359	15,193	15,644
6 ...	9,359	11,829	11,911	15,138

Potash and phosphate gave small increases in production but it is doubtful if lime has had any effect as yet.

This study will continue for a further year and then the land will be ploughed and planted to a crop to determine if there are residual fertilizer values.

DATE OF PLANTING

It is known that in single rainfall areas early plantings give higher yields than later plantings. This has been attributed to the later plantings receiving less rain than the earlier plantings and in some cases to a generally higher incidence of pests and diseases on the later plantings.

At Ilonga in 1957 the rainy season was unusually prolonged so that the March plantings received sufficient rain for setting a good crop. All crops however showed great reductions in yield per acre at the later plantings.

	Planting Date	
	Early January	Early March
Groundnuts	703 ...	192
Maize	3,176 ...	296
Soya	746* ...	556

*Early February.

A number of possibilities have been examined to account for this phenomenon i.e. generally lower temperatures, lack of available nitrogen and potash, but no adequate explanation has been found. In the three instances given above growth of stem and leaves was adequate for the production of a good crop, it was the production of seed only that was so drastically reduced.

The rate at which crop yields are reduced once the latest good date of planting is past is rarely appreciated. Figures extracted from local experiments are given below.

TABLE 10

Showing Rate of Reduction in Yield Once Last Good Planting Date is Passed—Lb. per Acre per Ten-Day Period

Maize	620, 335, 700, 70.
Sorghum	587, 740.
Cotton	178, 200, 255.
Sunflower ...	155, 215.
Soya bean... ...	144.
Groundnuts ...	136, 267, 86.

Arising out of these results it would seem that there are two problems of great importance. The first is to determine why such losses occur. It might then be possible to devise some method of at least reducing them. The second is to carry out a number of strictly comparable experiments to determine which crops are most affected and which least affected by this phenomenon. Such information would be of value in conjunction with other factors in determining the best planting succession in a system of agriculture. A beginning has been made on the second problem at Mwanhala.

TABLE 11

Effect of Date of Planting on Three Crops to which Fertilizers had been Applied—Lb. per Acre

	Groundnuts	Soya	Maize
11/12/57 ...	1,245 (87) ...	795 (100) ...	1,414 (88)
28/12/57 ...	1,442 (100) ...	449 (57) ...	1,614 (100)
16/1/58 ...	533 (37) ...	– ...	–
26/1/58 ...	– ...	392 (49) ...	991 (61)
4/2/58 ...	268 (19) ...	– ...	–
10/2/58 ...	– ...	231 (29) ...	753 (47)
22/2/58 ...	201 (14) ...	63 (8) ...	531 (33)

Figures in brackets are yields expressed as percentages of the maximum yield.

Maize and groundnuts gave their maximum yield at the second date of planting but soya bean gave its maximum at the first date and its yield was very considerably reduced by the second date. After the second date of planting yields of maize and groundnuts were reduced rapidly but the rate of reduction was appreciably greater in the case of groundnuts. Thus there would appear to be differences between crops that might be of value in determining planting sequences.

As to the problem of determining why such losses occur the Research Division is not able to undertake a full scale investigation of this problem involving as it does problems of crop physiology, soil chemistry and moisture relations and weather factors.

It might be possible in the case of maize and sorghum and perhaps cotton to select strains out of the variable material now being grown that will give generally higher yields if planted late. In the case of self-pollinated crops, groundnuts and many other legumes, which are less variable than cross pollinated crops selection is very unlikely to provide a partial solution to the problem.

Although yield is very considerably reduced as a result of late planting, growth generally is not so seriously affected. In one experiment a reduction in the growth of individual plants was shown at later planting dates but not in another.

TABLE 12

SHOWING EFFECT OF DATE OF PLANTING ON YIELD OF MAIZE, IN LB. PER ACRE AND ON GROWTH AS FRESH WEIGHT IN LB. OF 10 PLANTS EIGHT WEEKS AFTER PLANTING

Date of Planting	3 Jan.	11 Feb.	27 Feb.	11 Mar.
Yield of grain ...	2,543	1,236	1,745	1,123
Wt. of 10 plants ...	15·2	15·2	13·6	14·5

	11 Feb.	24 Feb.	18 Mar.
Yield of grain...	1,517	1,450	293
Wt. of 10 plants	21·5	15·3	11·9

In the case where late planting did reduce the fresh weight of the plant, grain yield was reduced to one fifth but plant weight to only one half.

This difference in the effect of planting date on fresh weight of plant and grain yield will be followed up in some detail as it may provide evidence as to the cause of the grain reduction.

IRRIGATION

Experimental work is carried out at Ikowa and Mang'onyi in the Central Province and Arusha Chini in the Northern Province.

There are a number of practical problems to be overcome before the full value of investigations at Ikowa and Mang'onyi will be obtained. These are largely due to lack of experience by the staff in handling crops under irrigation. The plant populations achieved were very low in most cases partly due to difficulty in wetting the ridges high enough to get water to the seed. Groundnut and sesame populations varied from 19 to 78 per cent of a full stand. Pests also did much damage to sesame, castor and cotton. There was a high incidence of an un-identified wilt on both varieties of groundnuts and Cercospora leaf-spot was severe on Natal Common. Asiriya Mwitunde showed a relatively high resistance to this latter disease. The value of the results discussed below must be assessed against this background.

On the red soil, fertilizers did not give any large increases of yield for groundnuts and sesame. Date of planting however had considerable effects on yields of both crops.

TABLE 13

EFFECT OF DATE OF PLANTING IN YIELDS LB. PER ACRE

	8 Jan.	22 Jan.	5 Feb.	19 Feb.
Groundnuts, Asiriya Mwitunde ...	688	770	403	378
Groundnuts, Natal Common ...	1,010	855	500	223
Sesame Local	305	380	290	213

Yields were generally low, those for the February planting being particularly low. Natal Common groundnuts yielded better than Asiriya Mwitunde.

Yields of Local and Dwarf castor were low, the best yields were obtained from plots treated with insecticides, 457 and 598 lb. per acre respectively. Production of flower seeds of various types was tried but without any great success. Zinnias gave the highest yield, 189 lb. per acre.

Cotton gave good yields when planted early on the red loam soil and alluvial grey silty clay when adequate control of pests was achieved. Plantings on the 1st January and 1st February gave the following yields per acre when dusted.

	Red Loam		Silty Clay	
	1st Jan.	1st Feb.	1st Jan.	1st Feb.
A	1,069	1,244	1,216	1,033
B	724	633	801	619

These yields can be regarded as promising but insect control was clearly inadequate At later planting dates yields were very poor.

On the grey calcareous soil, sesame and cotton gave extremely poor yields, Asiriya Mwitunde groundnuts produced 780 lb. per acre, West Nile sunflower 1,380 lb. and Katambili and Kalahari Early Pearl maize 2,120 and 1,520 lb. respectively. These crops were planted on 10th February and gave low yields on this account.

On the *mbuga* soil, rice broadcast on 24th January yielded 3,743 lb. of paddy per acre.

On the dry land area the following yields were obtained:

Maize:	
Katumbili	1,487
Kalahari Early Pearl	2,326
Groundnuts:	
Natal Common	930
Asiriya Mwitunde	939
Sunflower:	
West Nile	772
Sesame:	
Local	76

Yields of groundnuts and maize compare favourably with those obtained under irrigation.

At Ikowa the typical reduction in yield of groundnuts and sesame was shown by the later plantings on an irrigated crop. In spite of the practical difficulties mentioned above this result must be accepted as correct. Results obtained in 1957-58 at the Rujewa Trial Irrigation Farm of the Tanganyika Agricultural Corporation gave even more striking results. These are quoted below.

	Maize	Groundnuts	Soya	Castor	Cotton
30th November	6,760	675	955	1,200	2,785
27th December	4,120	1,305	1,885	1,550	1,790
1st February	2,060	65	1,045	1,420	2,140
3rd March	2,000	105	400	1,710	2,920
29th March	1,080	75	100	–	–
29th April	1,300	Nil	85	–	–

Losses in yield at later dates of planting have been a regular feature of irrigated rice at Mlali. At Lumemo, Tanganyika Agricultural Corporation Irrigation Trial Farm, Hibiscus var. ECR 985 × 986 yielded over a 1,000 lb. of fibre per acre when sown on 10th December, this was reduced to 750 lb. for a planting on 5th February and to 495 lb. on 5th March. Cotton at this station showed great reductions in yield at later planting dates. Early planting, i.e. December and January is not possible at this station since the early bolls open during a period when heavy rainfall occurs.

Date of Planting	Lb. Seed Cotton per Acre
4th February	1,639
4th March	801
5th April	299
5th May	251

Thus it may be concluded that the provision of an ample supply of water will not permit an extended planting season. On the contrary in view of the added cost of production under irrigation it is essential that planting of most crops must be early in order to ensure maximum yields. It may be tentatively concluded that plantings of the common cash and food crops during the dry season are not likely to be successful. This latter statement might only apply to the varieties commonly grown and that other varieties, if found, would be more successful.

For small irrigation schemes below small dams, providing a domestic and stock water supply, some production of vegetables in the dry season for local consumption might well be of value. For large irrigation schemes there does not appear to be any immediate prospect of producing two successive cash crops in one year.

INTERCROPPING

The work begun in 1957 at Ilonga and Mwanhala was continued. At Mwanhala the maize with groundnuts experiment was transferred to the site of the sorghum with groundnuts and *vice versa*. The conditions in the two years differed considerably, rainfall was generally unfavourable in 1958 and fertilizers were not applied. However, the same general conclusion was drawn from the results, i.e. that intercropping gave a higher production per acre than pure stands.

TABLE 14

Comparison of Yields from Intercropping and Pure Stands, Lb. per Acre, on the Basis of One Acre Intercropping and Two Half-acres of Pure Stands

Intercrop		Pure Stands	
Groundnuts	Maize	Groundnuts	Maize
193	413	118	287
Groundnuts	Sorghum	Groundnuts	Sorghum
213	93	99	91

In both experiments intercropping gave a higher production of groundnuts. For maize, intercropping gave the higher return, for sorghum production was the same for both methods. Sorghum was badly attacked by sorghum midge. These average results were obtained over a wide range of populations of both crops. It was calculated that 1·34 acres of pure stand would be required to give the same yield of both crops as one acre of intercrop for groundnuts and maize and 1·52 acres for groundnuts and sorghum. This is another important factor in evaluating the two methods.

At Ilonga the design of the experiment was modified to see if different arrangements of the two crops on the ground would give bigger yields than that adopted in the previous experiments and at Mwanhala, i.e. groundnuts and maize or sorghum planted in the same row.

Three arrangements were adopted:

A. Alternate rows of maize and groundnuts.
B. Maize and groundnuts uniformly distributed in the same row.
C. Maize and groundnuts in the same row but maize grouped at three plants per hill.

In addition weeds were allowed to grow in the rows of one set of plots in pure stand to compare the effect of weeds and intercropping.

TABLE 15

COMPARISON OF YIELDS FROM TWO HALF ACRES OF PURE STANDS, CLEAN AND WEEDY, AND ONE ACRE OF INTERCROPPING, LB.

	Pure Stands		Intercrop		
	Weedy	Clean	Alternate	Grouped	Uniform
Maize ...	540	668	1,034	1,043	1,154
Groundnuts ...	179	288	301	345	326

Allowing the weeds to grow caused an appreciable reduction in yield. There were no striking differences between the three types of intercropping. Maize production was much greater from intercropping but the groundnut production was about the same from both methods.

At Mnacho and Mtama in the Southern Province intercropping again proved to be appreciably the more productive method of growing maize and groundnuts. Other combinations of crops have been tested. In Handeni District maize and castor intercropped gave a higher return per acre than pure stands.

Pure Stands ...	158/- per acre.
Intercrop ...	201/- per acre.
Increase ...	43/- per acre.

At Mwanhala when castor was intercropped with groundnuts the castor gave no yield at all but the groundnut yield was not diminished. Maize grown with sweet potatoes caused a very great reduction in the latter, from two tons per acre in pure stand to half a ton. The sweet potatoes however had no appreciable effect on the maize yield.

Thus two years work has given no indication that there is any advantage, from the point of view of production, in advocating a change from intercropping methods to pure stands. The detailed results indicate that higher crop populations than are used in some areas could be recommended for local methods of intercropping.

The value of intercropping can be assessed in another manner. Using the yields produced by an acre of intercropping it is possible to calculate from the experimental data the acreage of crops in pure stands required to produce the same quantities.

TABLE 16

ACREAGES UNDER PURE STANDS REQUIRED TO GIVE THE YIELD OF ONE ACRE OF INTERCROPPING

	Ilonga Maize	Mwanhala Maize	Mwanhala Sorghum
1957 ...	1·16	0·99	1·24
1958 ...	1·44	1·34	1·52

In both years the labour requirements were greater for producing a given crop production in pure stands except in one case. In 1957 the rainfall was favourable at both stations In 1958 it was below average at both stations and the advantage of intercropping as regards labour requirements is appreciably greater in this year.

An indirect but great advantage in intercropping is that a greater proportion of the crops to be grown can be planted early with consequent higher yields.

WEED CONTROL

No work on chemical weed control is being done. The results of such work apply to only a small part of our agricultural economy and the results obtained in other parts of Africa can be utilized.

Work on the biological control of Prickly Pear is in progress. The scale insect *Dactylopius tomentosus* has been obtained from South Africa and established in Musoma District. The insect has multiplied rapidly and is proving an effective method of control. Sixty-four acres are now infested with *Dactylopius* and colonies of the insect are being established in other areas. Local Africans have been impressed by the control achieved and in some cases have taken infested leaves and fruit to establish the insect in their own districts.

INVESTIGATIONS OF LOCAL INTEREST

On small substations the work that is being done is largely directed to providing solutions for local problems i.e. the value of new varieties, determination of planting dates for maximum yield, value of manure or fertilizer and the suitability of new crops. This work can only proceed slowly at present because of the shortage of suitably trained and experienced Field Assistants to take charge of substations.

Wami-Magole Area, Eastern Province.

Two years work has been done so far. The soil is a heavy clay liable to water-logging. Rainfall records are scanty but suggest erratic distribution with a tendency to high rainfall in the months of March and April. Emphasis in the first two years was placed on time of planting experiments as local tradition favoured planting towards the end of February-beginning of March.

In 1957 the highest yields of maize, 2,175 lb. per acre, and groundnuts (var. Natal Common) 1,065 lb. per acre were obtained by planting on 31st January. Plantings on 18th January and 12th February were lower, 600 lb. less for maize and 400 lb. less for groundnuts. Very low yields were obtained from plantings on 4th and 18th March. The groundnut variety Mwitunde yielded 850 lb. per acre on the first two dates of planting and lower yields at later dates.

In 1958 owing to wet soil conditions the earliest planting was made on 8th February and subsequent plantings on 20th February and 10th March. Sorghum gave the highest yield at the first date of planting, 1,230 lb. per acre for Local Tall and 705 lb. for Dwarf Shallu. Groundnuts gave the best yields, 886 lb. for Mwitunde and 771 lb. per acre for Natal Common at the first two dates of planting. Results for maize were rather erratic, 2,285, 1,983 and 2,000 lb. per acre for the three dates of planting.

Results to date favour the suggestion that planting should begin about the end of January, Earlier planting cannot be recommended yet because of the danger of having to harvest during the likely heavy rain in April.

Fertilizer experiments do not show any decided economic returns. Trials with other crops are desirable i.e. castor and sesame. Soya bean was grown in 1958 but the best yield obtained was 570 lb. per acre. In spite of the useful yields obtained groundnuts are not likely to be successful locally owing to the difficulties of harvesting in the heavy soil.

Igumbiro near Iringa, Southern Highlands Province.

A small programme at this substation showed that early planting, 7th January, gave the best yields, maize 2,094 lb., Natal Common groundnuts 508 lb., and Mwitunde groundnuts 384 lb. per acre. The planting two weeks later showed appreciable yield reductions in all three cases.

Kisaki, Eastern Province.

At this substation the same general result was obtained, plantings on 8th February gave the highest yields, Natal Common groundnuts 1,229 lb. maize 2,822 lb. and local tall sorghum 1,505 lb. per acre.

Puchapucha near Tunduru, Southern Province.

This substation was started to carry out research on virginia tobacco production as it was considered that the surrounding area might be suitable for this crop. Tobacco production however was not successful. An extensive range of crops was planted to see if the site would be suitable for research on other crops. Yields were generally poor, sunflower producing only 1,025 lb. per acre. Plots of soya, bambara nuts and sesame yielded 750, 524, 540 lb. per acre respectively, other plots gave much lower yields. Elephant and other game destroyed appreciable areas of the different crops and the local cultivators avoid the prevailing soil type as they know it is unsuitable for their crops. For these reasons it was decided to close the substation.

Lilungu at Mtwara, Southern Province.

A crop sequence experiment showed that the yields of a number of crops were not affected by the type of crop previously grown. In Nyasaland however it has been found consistently that the highest yields of the second crop are produced following groundnuts and lowest following the same crops. Good yields were obtained at Mtwara but only maize gave increased yields to fertilizer application, 410 lb. per acre to 100 lb. each of single superphosphate and sulphate of ammonia.

A time of harvesting experiment on cassava showed that early digging gave lower yields than later digging and that growing a crop of groundnuts or sesame to occupy the land after early digging did not compensate in this instance for the reduced yield of cassava.

A number of dwarf varieties of castor were tested and gave promising yields varying from 700-1,100 lb., average 965, lb. per acre. Giant castor planted in October, 1956 produced 545 lb. per acre in the first year and a further 645 lb. to June 1958. The possible value of ratooning the giant castor in December, 1957 was tested. No difference was found between the yield in 1958 of ratooned and un-ratooned plants.

CROPS

Barley

Breeding and Selection.

A very limited range of material has been grown in the Northern Province, comprising 16 varieties from Kenya and 2 from Aden. None of these varieties were superior to Domen which is grown commercially in the area.

Beans

Plant Protection.

The 1958 season in the Northern Province was generally satisfactory and little trouble was experienced from diseases. Angular leaf spot (*Isariopsis griseola*) resulted in heavy defoliation. Mildew (*Leveillula taurica*) recorded in the Territory for the first time was quite severe on one farm.

The "oily pod" condition was again recorded on certain varieties, notably derivatives of Idaho Refugee. Nowhere were there serious losses. A further check on the possibility of fungal or bacterial infection was made but again negative results were obtained. Correspondence with authorities in Holland revealed that the condition has been reported there from time to time but that no pathogens fungal, bacterial or viral had been associated with it.

Bean-fly (*Melanagromyza phaseoli*) caused severe damage at Songea in July and at Lushoto in December. Trials have been laid down at the Northern Regional Research Centre to determine the season of maximum abundance locally and to test the value of seed dressings. Observations are still in progress but first indications are that:

(a) the fly is most abundant on plantings made out of season;

(b) seed dressing with Aldrin 40 per cent wettable powder at the rate of 1 lb. of powder per 100 lb. of seed gives a measure of control;

(c) the pest becomes a limiting factor only when the crop is growing under adverse conditions.

Cashew

Agronomy.

A plantation of cashew varieties imported from Trinidad, Jamaica, Ceylon, India, Malaya, Zanzibar, Mozambique, British Guiana and Nigeria has been established at Nachingwea.

It has already been shown that cashew seed which sinks in water or in solutions with a specific gravity up to 1·075 has a better percentage germination and more uniform rate of germination than seed which floats on water. Further work has shown that seed of a light density has a slower rate of growth than seed of a high density.

TABLE 17

EFFECT OF SPECIFIC GRAVITY OF SEED ON SUBSEQUENT GROWTH

Date	Specific Gravity of Seed: less than 1·00	1·025—1·050	greater than 1·075
	Height in inches		
20.3.58	7·63	9·07	9·38
13.11.58	34·47	42·90	43·75
	Number of leaves per seedling		
20.3.58	10	12	13
13.11.58	149	190	201

Seed sown December, 1957.

Thus choice of heavy density seeds is of particular importance in the successful establishment of a cashew plantation.

Plant Protection.

Work has continued on Helopeltis. The blanket dusting of an area of young trees begun in 1957 was continued using 0·5 per cent B.H.C. dust. Helopeltis attack did not develop during 1958 but it was found that the set-back to the undusted trees continued into 1958, dusted trees being approximately 7 feet high whereas the controls were 5 feet 8 inches high. The trees came into flower for the first time in 1958 and it was found that in this respect also the treated trees were superior to the control. A higher percentage of treated trees, 79 as against 44, bore inflorescences and also they bore twice as many inflorescences as the control, 9 as against 4. It is clear that the control of Helopeltis is of great importance in the establishment of a cashew orchard as the damage sustained in the first year may affect the subsequent rate of growth and has a bad effect on the shape of the tree. Badly attacked trees tend to send up numbers of basal branches which develop into an untidy bush rather than a clean-trunked tree.

The expected attack by Helopeltis did not occur on the blocks of trees chosen for insecticide experiments. However, part of the control block was infested with a leaf-feeding thrips, the Red Banded Thrip, and useful information was obtained. Damaged leaves are shed and infested trees can be picked out by their long bare shoots and paucity of leaves. Flowers are also damaged. There was a greater production of inflorescences on trees attacked by thrips, nut yield was however greatly reduced. One acre of infested three-year old trees produced 378 lb. of nuts as compared with one acre of undamaged trees which produced 637 lb.

The Theraptus bug, a pest of coconuts, spots and blackens young nuts and can cause considerable damage.

The life-cycle of the Cashew Bark Borer has been worked out.

MAIZE

Agronomy.

At Tengeru, near Arusha, farmyard manure at 5 tons per acre and sulphate of ammonia, at 250 lb. per acre continued to give good responses, 760 lb. and 1,100 lb. per acre respectively. Superphosphate alone and with sulphate of ammonia did not give any response. The experiment studying methods of disposing of stover continued to show no yield differences between removing, burning and ploughing in.

Breeding and Selection.

One programme aims at producing a very short season (60-70 days) self-perpetuating variety for hot areas with an average rainfall of about 25 inches. Three lines of work have been followed, a search for early maturity in East African varieties, direct use of importations and crossing amongst imported varieties and between imported and local varieties. Varieties have been imported from the Americas, South Africa, Ghana and India.

The results obtained were, on the whole, disappointing. The shortest "season" recorded was 80 days for an imported American hybrid at Nachingwea. It would seem that the desired growth period will not be attained easily. A variety M6sb2 ex Barretal yielded very well in a variety trial at Essimingor, 3,920 lb. per acre, forty per cent higher than any other in the trial. The local variety yielded 2,323 lb. per acre. Many of the introductions have been found to be particularly susceptible to Helminthosporium rust and provision is being made in the programme for resistance to this disease.

Another important programme that has just started is to try to produce a more drought resistant maize than any available at present.

A variety trial at Nachingwea comparing four Polysora rust resistant varieties with a bulk Katambili containing a mixture of resistant and susceptible plants showed that the improved Katambili out-yielded the rust resistant strains in this year of low rainfall.

TABLE 18

MAIZE VARIETY TRIAL

lb. per acre

Improved Katambili	1,407
Tanag No. 2 White (Flint)	1,070
Tanag No. 2 White (Dent)	1,012
Tanag No. 1 White (Dent)	760
Tanag No. 1 Yellow	513

It is thought that the poor performance of the four rust resistant varieties is due to selection for yield having been done under conditions of ample soil moisture during two dry seasons and an intervening favourable rainy season. It is possible that a series of varieties requiring high rainfall conditions or intolerant of low or irregular rainfall has been produced.

One of the important factors determining the yield of maize is plant population. Results generally show that a high population, about 12,000 plants per acre at harvest, is desirable to ensure maximum yield for the soil and weather conditions under which the crop is grown.

An exception to this generalization has been found at Mwanhala in the intercropping experiments of 1957 and 1958.

TABLE 19

SHOWING ADVERSE EFFECTS OF HIGH MAIZE POPULATIONS ON YIELD, MWANHALA

1957		1958	
Plant Population thousand per acre	Yield lb. per acre	Plant Population thousand per acre	Yield lb. per acre
3·9 ...	1,416 ...	3·8 ...	600
7·7 ...	1,990 ...	7·7 ...	640
11·0 ...	1,668 ...	11·6 ...	485

In 1957 a medium population of 7,700 plants gave the highest yield. In 1958 the medium and low populations gave the higher yields whilst the high population gave an appreciably lower yield.

In two fertilizer experiments, at Tengeru and Kiru valley, Mbulu, sulphate of ammonia gave appreciable increases in yield, 1,029 and 628 lb. per acre. Superphosphate did not give any increase in yield either alone or when applied with sulphate of ammonia. This is contrary to experience in most part of the Territory.

A high proportion of maize is planted late in the season. It was considered possible that since such plantings generally receive a low rainfall a lower population than 12,000 plants per acre might give the highest yield. The results of experiments at Ilonga carried out during 1957 and 1958 do not support this idea. In both years the highest plant populations gave the highest yields at the last date of planting, 1st March in 1957 and 18th March, 1958.

TABLE 20

EFFECT OF PLANT POPULATION ON YIELD OF MAIZE AT LATE PLANTING, LB. PER ACRE

Plant Population thousands per acre	Yields, lb. per acre 1957	1958
24·9	368	–
12·4	–	305
9·9	279	–
6·2	224	281

PAPAW

Plant Protection.

Damping-off (*Pythium* spp. and *Corticium Solani*) in nurseries and root-rot in the field caused by the same fungi have been causing considerable losses at Magara in Mbulu District. Much of the trouble in the field appeared to be the result of impeded drainage and also from planting out infected seedlings. Sun-scorch of young stems was partly responsible for the susceptibility shown by the seedlings and shading the seed-beds gave significant control of damping-off. Greenhouse experiments using various organic fungicides as soil drenches showed that "Zineb" gave excellent control of damping off without phytotoxic effects.

Mildew (*Ovulariopsis papayae*) is causing serious loss of leaves in some areas. The practice of overhead irrigation under high temperature conditions appears to favour the development of mildew.

PEAS

Plant Protection.

During the course of a phytosanitary inspection of peas grown for seed in the Dabaga, Mufindi and Mporotos areas of the Southern Highlands Province the principal diseases encountered were Downy Mildew (*Peronospora viciae*) and Powdery Mildew (*Erysiphe polygoni*). Pea bacterial blight (*Pseudomonas pisi*), first reported in 1951 and at times between 1951 and 1953, has not been recorded in this area since.

PYRETHRUM

Agronomy.

The volume of work on pyrethrum was lower than in former years as the first programme of research is coming to a close and the next is being planned.

Two experiments at Uwemba using "Dutch Mixture", a proprietary fertilizer containing 30 per cent P_2O_5 and 6-7 per cent N, in addition to superphosphate and basic slag have given interesting results. Extracts from the results are given below.

TABLE 21

EFFECT OF DUTCH MIXTURE IN THE PRESENCE AND ABSENCE OF BASIC SLAG OR SUPERPHOSPHATE ON YIELD OF DRIED FLOWERS FOR 1957 AND 1958 ON TWO SOIL TYPES

	Black Soil		Red Soil	
	Nil	D	Nil	D
Nil	591	775	273	449
40 lb. P_2O_5 as basic slag	679	791	393	418
40 lb. P_2O_5 as superphosphate	632	815	355	371

D = Dutch mixture 200 lb. per acre or 60 lb. of P_2O_5 and 13 lb. of N.

Higher rates of basic slag and superphosphate were also tested but did not raise the yield above that given in the Table. On both soil types Dutch Mixture alone give a higher yield than either basic slag or superphosphate alone. It maintained this superiority when applied with both fertilizers on black soil but not on red soil. The inference is that the presence of nitrogen in the Dutch Mixture is responsible for the extra response. It is unfortunate that no proper investigation of the effects of nitrogen in the presence of phosphate has yet been done. It will be done in 1959.

There has been considerable uncertainty as to the value of cutting back the plants after the main rainy season flush. An experiment was carried out on pyrethrum planted early in 1956, and cut back in November, 1957. The results showed not only that cutting back was unnecessary but reduced yields by about 100 lb. of dried flowers per acre.

No cutting back	549 lb.
Cut back 15th March	442 lb.
Cut back 15th April	437 lb.
Cut back 15th May	407 lb.

A variety trial carried out by a local farmer, Mr. C. Maher, confirmed previous results that local varieties gave superior yields to varieties obtained from Kenya.

Lb. Dried Flowers per Acre

Local	ex Kenya
200	93
158	71
126	53

A large number of trials testing the value of micronutrients in various combinations as recommended by the Government Chemist were laid down. No evidence was obtained that application of these would bring about an increase in yield of pyrethrum.

Die-back resulting in reduced stands has been investigated at West Kilimanjaro and Oldeani. The cause of reduced stands seems to be complex, partly due to fungi and partly to insects. Also, primary insect attack may provide a means of entry for fungi. A species of *Pythium* has been isolated frequently from the stems of rotting plants. Planting on ridges to avoid water-logging has been recommended to prevent such rotting. A prophylactic treatment of the setts before planting out by dipping in a 50 per cent copper fungicide (5 lb. per 100 gal. of water) has been recommended to protect roots damaged during transplanting.

On Meru the main insect pests are soil insects, a Cetoniid (*Micrelaphinus adsperula*), an unidentified Melolonthid and a Tipulid. Leaves and flowers are damaged by onion thrips (*Thrips tabaci*) and red spider mite (*Tetranychus telarius*). The application of dusts of 1·25 per cent and 2·5 per cent Aldrin and 1 per cent gamma BHC in planting holes resulted in a satisfactory control of soil pests. The BHC dust improved the percentage of establishment from 74 to 92, and both Aldrin dusts to 99 ten months after planting. The application of BHC dust costing Shs. 17/50 per acre for the insecticide has become routine practice on estates where soil pests have been recorded in numbers.

Control of thrips and red spider on Meru is difficult as tractor-mounted sprayers cannot be used on the steep slopes and water for spraying is not obtainable in sufficient quantity. An effort has been made to reduce the general level of infestation by ensuring that planting material in the nursery is not infested when removed to the field. Rogor 0·04 per cent spray has been found to give a very high degree of control of red spider. Its value against thrips has not yet been ascertained.

At Uwemba the main insect pest is thrips. A heavy infestation which apparently began to build up with the onset of the warmer weather in August caused severe damage. Preparations are being made to spray with DDT should the pest appear in numbers next year.

Rice

Breeding and Selection.

At Mlali, Morogoro District, in a variety trial four selections from the previous season were compared with local Kahogo and Afaa.

TABLE 22

LB. PADDY PER ACRE

		Remarks
Afaa	5,229 ...	Very Variable.
A/0/759	5,710 ...	1 ft. 11 in. high uniform later maturing.
D/1/104	5,149 ...	3 ft. 4 in. high extremely tall.
A/1/158	5,042 ...	2 ft. 11 in. high good uniform variety.
Kahogo	4,413 ...	2 ft. 10 in. very spreading.
C/2/214	3,640 ...	2 ft. 6 in. high very early ripening.

Selection C/2/214 was the poorest yielder. A/0/759 appears to be promising from the yield point of view and uniformity of growth. Unfortunately it was not rated as high as Kahogo and Afaa in a cooking and tasting test.

A wide range of varieties has been tested at Mahiwa, Lindi District, during the past two years but none has so far proved to be appreciably better than a local variety Lindi Safara. At Chambezi three selections 1/194, 1/324 and 1/166 gave appreciably higher yields than Kahogo, Gamti or Borakupata.

SORGHUM

Breeding and Selection.

Further work on the BC2MS back cross (ex Ukiriguru) at Nachingwea showed that selections were still not breeding true. It is hoped that pure lines will be selected in 1959 for earliness, short straw and good grain quality.

SUGAR CANE

Agronomy.

A collection of new varieties, free from ratoon stunting is being maintained at Morogoro. These varieties have been introduced from abroad through the quarantine station of the E.A.A.F.R.O. and a further period of field quarantine at Kawanda, Uganda.

Plant Protection.

Chemical control of the red cane beetle *Cochliotis melolonthoides* is being obtained at Arusha Chini by using Aldrin in the planting furrow. The degree of control in ratoon crops is not as satisfactory as desired and attention is being turned to the possibility of biological control.

TOBACCO

Agronomy.

At Urambo fertilizer experiments were carried out over a period of four years by the Tanganyika Agricultural Corporation. An examination of the results suggested that nitrogen and potash were very important for increasing yields and quality but that the average effect of phosphate over the four years was negligible. A further experiment was planted to test this conclusion.

TABLE 23

EFFECT OF FERTILIZERS ON YIELD OF TOBACCO LB. CURED LEAF PER ACRE

	84 lb. K_2O		168 lb. K_2O	
	34 lb. N	45 lb. N	34 lb. N	45 lb. N
No phosphate	889 ...	869	931 ...	903
40 lb. P_2O_5	967 ...	1,016	899 ...	889
Difference	+98 ...	+157	—32 ...	—14

The yield of cured leaf without fertilizer application was 355 lb. per acre. All combinations of fertilizers considerably increased yields. Yields from plots given the same treatment varied considerably but none of the differences shown are significant. There is a suggestion that phosphate may have improved yields at the lower level of potash. This work will be continued as it is particularly important that fertilizer requirements for tobacco be accurately known.

Plant Protection.

Outbreaks of Anthracnose (*Colletotrichum tabacum*) at Urambo and Chunya reported at the end of 1957 were brought under control with "Zineb" fungicides. Cases of field infection were noted sporadically throughout the season. Localised outbreaks of Angular spot (*Pseudomonas angulata*) were reported from Urambo.

Wheat

Breeding and Selection.

This work is directed towards producing quick maturing wheats with resistance to rust diseases suitable for conditions in the Northern Province. The presence of a large number of physiological races of stem rust complicated by a great acceleration in the rate of production of new races in the last eight years necessitates building up a very wide range of wheats carrying some measure of resistance on which to work. In the last four seasons the number of varieties in the Northern Province has decreased from seventeen to the position in the 1958 long rains crop when two poor baking quality wheats made up 84 per cent of the acreage.

Material for study has been collected from a wide range of places. Important sources are the 500 varieties in the International Rust Nursery and the Plant Breeding Station Kenya.

During the 1957-58 short rains rust attack was negligible and selection was based on yield, straw strength, earliness, etc. However during the 1958 long rains rust infection was severe and 580 varieties out of the 640 tested were discarded. Seventeen out of the 60 varieties retained are promising as regards rust resistance, having shown either no reaction or resistant reaction to stem rust.

Plant Protection.

Powdery Mildew (*Erysiphe graminis*) appeared in wheat at Oldeani and was widespread but not serious. This disease has only been reported occasionally in the Territory previously.

Wheat rusts (*Puccinia graminis*, *P. glumarum* and *P. triticina*) were present on all main crops but nowhere did they cause any appreciable loss.

Pasture

Agronomy.

At Tengeru introductions were confined almost entirely to species and strains of grasses and legumes of which seed is available commercially from other countries. A total of 20 new species was introduced.

Outstanding amongst these was the Molopo strain of *Cenchrus ciliaris*. The Ermelo strain of *Eragrostis curvula* has proved disappointing in its first year. On the heavy black clay at Oljoro two strains of *Panicum coloratum*, Bambatsi and Villa Gouveia, have stood up well to flooding in the rains and to extensive severe cracking of the soil in the dry season. The annual *Medicago orbicularis* (Button clover) grew satisfactory on this soil but it is doubtful if it produced sufficient seed to re-establish itself.

In the Comparative Production Trial established in 1956 the two varieties of Elephant grass again outyielded all other species. The yield from Russian comfrey was considerably reduced. In a trial started in 1957 to compare the effects of cutting once a month and once every two months on a wide range of grasses it was found that monthly cutting tended to reduce yields.

Advisory and grassland survey work was continued particularly in the Mbulu District, Masailand and on estates.

At Nachingwea a pasture of Rhodes grass was established as part of an experiment to compare three farming systems. It grew well and provided a supply of fodder throughout the dry season.

Plant Protection.

Helminthosporium (?) *cynodontis* was found causing severe leaf-spotting and die-back in a *Cynodon dactylon* pasture on Kilimanjaro. Extreme susceptibility may have been caused by soil exhaustion and various manurial treatments were recommended.

Castor

Although exports of castor have varied between 7,870 and 13,894 tons during the past six years and were valued at £860,069 and £812,187 in 1957 and 1958 very little research work has been done to date on this valuable crop. Most of the crop comes from small patches planted in odd corners of peasant farms. Rarely is it grown in bulk. When grown

on experimental farms losses due to insect damage have been high. A programme of research has been drawn up to study three important aspects of castor production, pest control, improvement of varieties and general agronomical studies. Of these pest control is the most important as until damage from pests can be appreciably reduced, full value will not be obtained from other lines of work.

Agronomy.

Several experiments on the effect of date of planting on yield have been carried out.

TABLE 24

EFFECT OF DATE OF PLANTING AND INSECTICIDE APPLICATION ON TWO TYPES OF CASTOR AT ILONGA AND IKOWA

lb. seed per acre

Month of Planting	Dwarf		Giant	
	Undusted	Dusted	Undusted	Dusted
ILONGA				
January	317	418	653	1,097
February	188	395	445	603
March	172	204	422	409
April	132	184	60	117
May	118	188	7	5
IKOWA				
January	115	329	197	393
February	46	235	46	374
March	Nil	84	12	170
April	Nil	26	Nil	Nil

The dwarf variety used was one of a number obtained from S. Africa for testing and is grown as an annual.

At both places the characteristic diminution in yield with later planting occurred. At Ilonga and Ikowa yields from the Giant variety were markedly superior to those from the Dwarf, for the January, February and March plantings. However at Ilonga, the yield from late planted Dwarf was generally higher than from late planted Giant, due no doubt to earlier flowering and seed setting. Dusting with cotton dust at weekly intervals for twelve weeks gave some increase in yield but this was not commensurate with the cost at any date of planting. At Ilonga planting one month earlier gave an equivalent yield to that obtained one month later with dusting.

Of the trials carried out in the Lake Province only that at Lubaga produced useful yields, insect attack at most sites being heavy. At Lubaga the South African Dwarf varieties produced yields varying from 497-713 lb. per acre. Maswa local produced 193 lb.

Breeding and Selection.

Throughout the season selection of Dwarf and Giant types showing useful characters has continued. A promising selection from Giant castor at Ismani is being specially bulked for trial.

Variety trials comparing various Dwarf and Giant varieties were carried out in ten localities. Yields were generally poor, usually as a direct result of insect damage and sometimes to late planting. On a trial farm belonging to the Tanganyika Agricultural Corporation at Rujewa in the Southern Highlands Province yields were remarkably high. Two factors especially contributed to this, irrigation and comparative freedom from insect pests. Dwarf varieties gave yields varying from 500 to 1,410 (average 1,064) lb. per acre. A local Giant planted in 1958 yielded 1,460 and the same variety grown as a perennial yielded 2,140 lb. er acre.

Plant Protection.

By far the most important factor limiting yields in Tanganyika is damage by insect pests. A number of sucking bugs, particularly *Lygus vosseleri* are the most serious pests.

The castor fruit is unusually susceptible to insect damage. Damage by a sucking bug is almost inevitably followed by the fall of the fruit, even if only one of the developing seeds within the capsule has received superficial damage. Dwarf castors appear to be more susceptible to insect attack than the giant types. In table 25 the dusted plots of dwarf gave an increase in yield of 35 per cent, those of the giant only 17 per cent. A greater degree of tolerance appears to be present in locally occuring wild castor.

Little is known of the mechanism of this tolerance. It seems probable that in wild castor there is physiological tolerance not present in the cultivated varieties, as relatively severe damage is needed to cause fruit fall. In cultivated giant castors the capsule is relatively thick and this may account for the greater tolerance of these types as compared with the Dwarf. A further point of importance is that the Giant types generally have a later flowering period than the Dwarf so that the major period of fruit set does not coincide with a period of very high pest incidence.

The results obtained from dusting trials were most disappointing and gave no hope of economic control.

TABLE 25

SHOWING THE EFFECT OF WEEKLY DUSTING FOR 15 WEEKS WITH COTTON DUST (10 LB. PER ACRE PER APPLICATION) ON YIELD OF TWO TYPES OF CASTOR, LB. PER ACRE—ILONGA

	Dwarf		Giant	
	Not Dusted	Dusted	Not Dusted	Dusted
Harvested before 14.10.58	152	367	42	258
Harvested after 14.10.58	203	112	423	285
Total	355	479	465	543

The trial was not replicated and so no great reliance can be placed on any inferences drawn from the results. There are two points of interest. One is that the yield of undusted Giant is very similar to that obtained from dusted Dwarf. The other is that a high proportion of the yield from the undusted plots was obtained after mid-October and the reverse was the case for the dusted plots. This point is of particular interest in view of the poor response to insecticidal dust.

The degree of insect damage varied greatly throughout Lake and Western Provinces. It was severe at Urambo, Lubaga, Ukiriguru and Musoma but light at Mwanhala and North Mara. The most serious damage was done to the buds and fruits by *Lygus vosseleri*, *Lygus* sp., *Megacoelum* sp., *Calidea dregii*, *Nezara viridula* and *Ptylus grossus*. Leaf damage was done by larvæ of *Euproctis rubricosta*, *Heliothis armigera*, *Orgyia miata*, *Prodenia litura* and *Achaea catella*.

At Ilonga it was observed that at the beginning of the rains only a few sucking bugs could be seen on the castor, but that numbers built up rapidly reaching a maximum in June and July. Thereafter they diminished rapidly and by the end of August very few were present, insufficient to cause any damage. It is hoped that use may be made of this observation to devise a method of growing castor by planting it in February in a low growing legume crop to miss the devastating insect attack on the early candles.

COCONUTS

Agronomy.

No benefits from the application of artificial fertilizers to young and adult palms have yet been demonstrated.

An examination of past records of individual palms showed a number that had produced an average of over 100 nuts per annum for four successive years. Cross pollination between these palms was carried out and 75 inflorescences pollinated early in the year have set 235 nuts. The remainder have not yet reached a sufficiently advanced stage for the success of pollination to be determined. Nuts from these trees will be established in isolated plantations to test their value.

Groundnuts

Agronomy.

In the Lake Province extended trials of the two groundnut varieties, Natal Common and Mwitunde, were carried out at several dates of planting. In all cases except one, December plantings gave the highest yields. The results for this month are given below.

TABLE 26

Yields of Groundnuts in Shell Lb. per Acre

	Natal Common	Mwitunde
Ukiriguru	1,471	1,367
Malya	1,609	922
Lubaga	836	450
Tarime	1,833	1,670
Kinesi	762	762
Kisangwa	670	577

At Kinesi the February planting of Mwitunde gave the highest yield, 871 as against 762 for December. Natal Common outyielded Mwitunde and should be grown unless rosette disease is severe in the locality, when Mwitunde, which is resistant, is the obvious choice.

Plant Protection.

An unidentified wilt has caused serious losses of stand in experimental plantings at the Ikowa Irrigation Scheme. No obvious lesions were found on the roots or stems and there was no evidence of discolouration within the stems or bacterial exudation.

Sesame

Plant breeding and selection.

In 1957 five varieties imported from Venezuela were tested. Two varieties Venezuela 51 and 52 appeared to be promising. Two indehiscent varieties from the U.S.A. were also tested and found to be distinctly undesirable in all characteristics except indehiscence. Results in 1958 again showed that the U.S.A. varieties were useless locally except as a source of the indehiscence gene. The variety Morada from Venezuela showed up particularly well in a year of rather unfavourable rainfall distribution. In a variety trial Morada yielded 348 lb. per acre and the local 175 lb., a highly significant increase. The other Venezuela varieties yielded less than the Local.

In a bulk planting of Morada on a production farm of the Tanganyika Agricultural Corporation an overall yield of 808 lb. per acre was obtained. On the same farm Local averaged some 200 lb. per acre. Morada is a selection from an African variety. It is branched, resistant to lodging and aphid attack, and suffers only lightly from *Cercospora* and *Alternaria* diseases.

It is thought that these varieties from Venezuela will prove important in increasing sesame production.

The aims of the breeding programme are as follows:

(a) the production of dehiscent varieties with high yield and drought resistance. Both branched and unbranched types will be sought. The pedigree system of breeding will be used and it is hoped that these types will be obtained without difficulty.

(b) the production of indehiscent varieties, branched and unbranched, with high yield and drought resistance. Since the varieties used as a source of the indehiscence gene are generally unsuitable for the area a series of back-crosses to the dehiscent but otherwise desirable parent will be necessary to isolate the indehiscent character from associated undesirable characters.

First back-crosses have been made and also a number of multiple crosses so that a wide range of genetic diversity can be obtained.

Plant Protection.

At Ukiriguru sesame was almost completely destroyed by *Antigastria catalaunalis*. At Mwanhala, 150 miles to the south, early plantings suffered some damage but later plantings gave a good stand.

Agronomy.

American workers claim that there is a marked seasonal × variety interaction on yield and that a mixture of varieties has a stabilizing effect on yield. This claim is being investigated but at least three years results are necessary before an assessment of its value can be made.

In an experiment at Nachingwea to study the actual period during which the yield is put on in this crop, it was found that about 20 per cent of the yield was formed within 12 weeks of planting. The remaining 80 per cent was formed in the next three weeks, confirming the results of a previous experiment. This point is of importance in considering time of cutting, if the crop is to be cut and stooked for threshing later.

Variety trials in the Lake Province showed that December plantings gave the highest yields and that Hernon 237 was the highest yielding variety generally.

TABLE 27

Yields of Three Varieties of Soya Bean Lb. per Acre

	Hernon 237	Light Speckled	C N S
Ukiriguru	707	461	517
Lubaga	106	19	102
Kisangwa	588	512	569
Kinesi	327	436	218
Nyamahona	1,053	356	799
Tarime	673	769	581

Plant breeding and Selection.

A wide range of varieties from Ceylon, the Philippines, Guinea, Nyasaland, Belgian Congo Malaya, India and Nigeria was grown in observation plots at Nachingwea. None proved more suitable than the range of material already utilized in the breeding programme.

A single plant selection from Hernon 237 has out-yielded the parent variety in three successive years and is being bulked up for issue as Hernon Nachingwea.

	1956	1957	1958
Hernon 237	997	1,849	714 lb. per acre.
Hernon Nachingwea	1,540	1,919	989

The results of a single plant strain trial of Benares suggest that some selections may be even higher yielders than selections out of Hernon 237.

Individual plant selections, made in 1957 from fourth year segregating populations of three crosses, were grown in progeny rows. They bred true for height, maturity date, habit and resistance to lodging but most were still segregating for yield. Individual selections for high yield were made and were grown under irrigation during the dry season to obtain sufficient seed for replicated trials in 1959.

The most promising cross appears to be Light Speckled × Hernon 237 and some good varieties should be produced by it. The average yield of individual selections was 32·4 g. compared with 23·2 g. and 22·3 g. respectively for the parents grown in adjacent rows. One line appears, from its rank indeterminate growth and mass of foliage, to be useful as a forage/silage variety.

Material from the other two crosses MIS28EB × R184 and Light Speckled × CNS is not so promising generally but a few lines show promise.

Plant Protection.

Soya beans were heavily infested by a white-fly *Dialeurodes* sp.? *citri* at Wami, Morogoro District in mid-May. Severe damage by all stages of *Acrosternum pallidoconopersa* was done to the crop at Magara in early January.

The crop at Lubaga was badly damaged by the Elegant Grasshopper (*Zonocerus elegans*).

Cocoa

Agronomy.

Seed of seven varieties received in June from Accra was planted in pots. By the end of the year all seedlings were ready for planting out. These seedlings will be planted out at four places in Tanga Province.

In an investigation to study the possibility of prolonging the viability of cocoa seed in the pod, it was found that this could be effected by covering the pod with a coating of clear cellulose lacquer. The untreated pods became soft after seven days, on the eleventh day the seed was soft and starting to ferment. Three days later the seed was discoloured and badly fermented. The seed in treated pods was showing only very slight fermentation on the fourteenth day and by the twenty-first day fermentation was still slight. It was severe however, six days later. Thus it does appear possible for the seed to remain viable for 14 days using this method.

Plant Protection.

The chief pests found at the Maramba estate, Eastern Usambaras, were the sucking bugs, *Helopeltis bergrothi H. anacardii* and *Pseudotheraptus wayi* which cause severe damage to the fruit and the mealybug, *Planococcus citri*, which causes severe distortion of the plant by damaging the growing point. It is particularly troublesome on young trees.

The following control measures have been advised:

(a) the use of 0·5 per cent gamma BHC dust against *Helopeltis* and *Pseudotheraptus;*
(b) direct control of the mealybug using Malathion or Rogor;
(c) the use of Dieldrin as a band about the base of all trees to control the ant, *Pheidole*, attendant on the mealybug.

"Ring-barking" damage has been noted at the base of the branches, but no insect causing the damage has been found.

Coffee

Agronomy.

Robusta

A plot of mixed local types was planted in 1953 at the Maruku Coffee Station, Bukoba District, on poor rweya soil with a small amount of farmyard manure. Growth was poor initially so a heavy mulch of grass was put down and has been maintained. During the past two years growth has been good and although the habit of the trees varies considerably most of them are well grown and vigorous. In 1957-58 the average yield was 1·7 lb. of clean coffee per tree (513 lb. per acre) and in 1958/59 it was 2·6 lb. per tree (800 lb. per acre). The best tree yielded 11·3 lb. during the current season. This plot is now being used as a source for possibly higher yielding varieties.

In view of previous failures to establish Robusta at Maruku an experiment was planted in 1956 to test the value of farmyard manure, fertilizers and lime on establishment alone and in combination. As yet, lime has not had any effect on growth but the application of two "debes" of farmyard manure with 8 oz. of double superphosphate, 8 oz. of sulphate of ammonia and 4 oz. of muriate of potash in the planting hole, together with an annual dressing of the same amounts of fertilizers applied in three split top dressings, has resulted in an appreciable increase in growth and sturdiness. The average height of the control trees after 2 years was 27 in. compared with those treated as above which attained 37 in. The cost of such a treatment is admittedly high but the experiment has shown that standard methods of improving soil fertility will result in the establishment of a healthy coffee tree. The results obtained from the initial plot of coffee planted at Maruku suggests that maintenance of production is quite likely. It is now necessary to find out whether reduced quantities of fertilizers will give good establishment.

In a root study trial, it was found that the lateral feeding roots had spread out to 5 feet from the tree two years after planting and the tap root had penetrated to a depth of nearly 4 feet. Where the planting hole had been filled with compost, the feeding roots were distributed throughout the planting hole but were restricted to the top foot of soil outside the planting hole.

Interplanting bananas and coffee has resulted in a reduced rate of growth of the coffee.

TABLE 28

HEIGHT IN INCHES OF COFFEE SEEDLINGS ONE YEAR AFTER PLANTING OUT AMONG BANANAS ESTABLISHED SIX MONTHS PREVIOUSLY

	Banana density in stools per acre			
	0	100	200	400
Robusta	16·7	14·2	10·1	8·0
Arabica	32·2	28·8	23·7	13·2

Germination tests were carried out to see how long Robusta coffee seed could be safely stored. It was found that seed four months old had a percentage germination of 58, at five months 28 and at seven months only 3.

Numerous other experiments have been planted at Maruku or at out-stations but are not yet producing results. These include:

At Maruku.

A clone trial to compare 20 local and 12 Uganda selections.
A nitrogen and ground treatment experiment.
A pruning experiment.

Out-stations.

A mulch, compost in planting hole and sulphate of ammonia in two top dressings annually experiment (Kaibanja and Kituntu).

A spacing, pruning and variety experiment (Kaibanja).

Arabica

In Bukoba and Karagwe districts variety trials have been planted. Seedlings planted at Kituntu with two debes of farmyard manure per hole have grown 32 inches in twelve months and those without farmyard manure have grown 20 inches. In both trials the varieties SL 28, SL 34, N 197 and the Local grew more than the average. At Maruku K7 was completely free of Hemileia leaf rust and the Kents varieties were only slightly infected. All other varieties were 100 per cent infected.

The effect of various densities of bananas stools on the growth rate of Arabica coffee is considerable, see Table 28 above.

At the Mbozi coffee research station in Southern Highlands Province a solution to the problem of establishing vigorous healthy trees without irrigation does not yet appear to be in sight. Improvement in the method of planting gave some improvement in growth during the early stages of growth but after the first crop the trees seem to lose their vigour and die-back occurs frequently.

In the mulch and nitrogen experiment (planted 1954) the coffee maintained a fairly healthy appearance until April when the rains ceased. Then leaf shedding and formation of "buni" started to occur. The general loss of vigour continued until November when the rains started, and a slight recovery was made. A similar recovery was noted in the two previous seasons. The yields from this experiment are pitifully low.

TABLE 29

YIELDS, AVERAGED OVER MULCH TREATMENTS FROM SINGLE AND MULTIPLE STEMS WITH AND WITHOUT NITROGEN FOR THREE YEARS, LB. CLEAN COFFEE PER ACRE

	Single	Multiple
No Nitrogen	0·51	0·87
Nitrogen	0·59	0·92

The pruning experiment (planted 1954) showed the familiar symptoms of leaf yellowing and shedding die-back and "buni" formation in July, the symptoms not being related to treatments. The mean yield in the experiment over three years is 75 lb. of clean coffee. Statistical differences between single stem and elaborate pruning methods are of no practical importance at this level of yield.

The trees on the large fertilizer experiment involving all combinations of sulphate of ammonia, phosphate, potash and lime at three levels (planted 1954) showed leaf yellowing and shedding in September. A visual scoring showed that the least affected coffee was generally in the plots treated with nitrogen followed by these treated with potash. There was no evidence of an additive effect. There was a suggestion that the symptoms tended to be more severe on the phosphate plots. After the rains began it was noticed that weed germination was markedly greater on the phosphate plots. Thus there is a possibility that the extra utilization of water on the phosphate plots by heavier weed growth may intensify leaf yellowing and shedding. Yields were poor being in the range of 20-40 lb. of clean coffee per acre.

It has been decided to strip the trees for two years on this experiment and on several of the replicates of the Variety trial, in the hope that more vigorous top and root growth will occur.

On the Irrigation Plot 1 (planted 1956) growth is most impressive generally. Apart from some chlorosis in new leaf put out during August and some tip-blackening, from which full recovery was soon made, no set-backs have yet occurred. The un-irrigated half already appears to have settled down to the struggle for existence typical for the station—what new leaf there is being small yellow and distorted.

Following the discovery that even when large planting holes, 2 feet × 2 feet × 2 feet were dug, allowed to "weather" for several months and then refilled with top soil plus some farmyard manure, growth of the root system downwards was restricted to the planting hole and laterally to the top foot of soil, it was obvious that in order to have any hope of producing a healthy coffee tree it would be necessary to:

(a) encourage the tree to develop a deeper root system, or
(b) maintain the first two feet of top soil at a moisture content and fertility level such that a superficial root-system would suffice.

Trials have been planned to see whether it is possible to induce the plant to develop a deeper root system. In an area with a six months dry period a deep root system is essential. It is remarkable that the trees can even survive for four years with such a restricted root system. In addition mulch and fertilizer treatments have been planned for Irrigation Plots.

Dr. Pereira, East African Agriculture and Forestry Research Organization, has advised that attention should also be given to the production of a suitable local climate around the trees by means of shade and windbreaks to mitigate the effects of dry winds and wide range of diurnal temperatures during the dry season.

A variety trial on Ng'amba Estate (planted 1953) bore its heaviest crop to date, nearly 3 cwt. of clean coffee per acre. A zinc boron spray applied to half-plots for two successive years had no effect on yield.

Plant Protection.

Rust (*Hemileia vastatrix*) has again been severe in the main Arabica areas. In an experiment at Lyamungu, in which trees have been treated monthly with copper (oxychloride) sprays and insecticide to control leaf-miners, it was noted that leaf retention was markedly greater on the copper-sprayed trees both with and without insecticide. A number of Hemileia spots were present on the leaves of sprayed trees.

Weekly records at Lyamungu over the past two years have given a clear picture of the build-up of Hemileia infection in relation to rainfall. It is considered that at least five sprayings with conventional copper fungicides will be necessary to secure adequate protection of new foliage against the frequently recurring infections under the prevailing conditions. There are a number of factors that weigh against such a programme becoming general practice, the principal one being the high cost.

Stem-pitting, first reported 1956, has now been found in practically all the Arabica areas but to date no cases have been reported for Robusta. There is some evidence from examination of tree sections that affected plants may recover from the symptoms (i.e. the stem once again assumes its normal smooth outline). The study of stem-pitting is now in the hands of Dr. F. M. L. Sheffield, East African Agriculture and Forestry Research Organization.

Bark disease (*Fusarium lateritium* var. *longum*) is becoming increasingly important. Several deaths have been reported following infection in Rungwe District. On Kilimanjaro the disease has been found in constant association with a die-back of leaders on estates and African holdings. There is a suggestion that the fungus has gained entry via leaf scars and pruning cuts possibly during a wet period which has facilitated infection. Spraying with a fungicide to run-off immediately after pruning has been recommended as a possible method of control.

Cotton

Agronomy.

In an experiment at Ukiriguru, comparing three UK. strains and three strains from the Albar 51 hybridizing programme of differing lengths of maturity at 4 dates of planting, the typical reduction in yield with later planting was recorded. The very early maturing strain M/12/15/385 looked spectacular at the time of the earlier pickings, but was caught up and surpassed in the later pickings by the later maturing strains. This work is continuing.

In observation plots the set-back to the crop from delayed early weeding was very striking, a 40 per cent drop in yield. For cotton planted on the flat where early weed growth was more serious than with ridged cotton, the drop in yield compared with tie-ridged cotton was approximately 45 per cent.

A feature of the season has been the comparatively high level of control yields, about 650 lb. seed cotton per acre, from land that has been cropped at a high standard of management. Responses to fertilizers have also been satisfactory except that the positive N P interaction characteristic of the application of sulphate of ammonia and superphosphate has not been shown. Yield figures showing the responses obtained in three experiments from simple treatments are given below as illustrative of their value.

TABLE 30

Yields of Seed Cotton, Lb. per Acre, 1958

Trial 9—Eleventh year of Experiment

Treatment	*Yield*	*Response*
A.—Nil	926	–
B.—75 lb. basic slag applied 1950/51 and 1956/57 and 90 lb. urea applied 1958	1,253	327
C.—6 tons FYM applied 1950/51 and 1956/57	1,580	654
B + C	1,748	822

Trial 26—Seventh year of Experiment

A.—Nil	568	–
B.—150 lb. double superphosphate applied 1951/52 and 1954/55 and 50 lb. sulphate of ammonia applied 1958	1,106	538
C.—6 tons FYM applied 1951/52 and 1954/55	1,094	526
B + C	1,253	685

Trial 44—First year of Experiment

Nil	1,219	–
100 lb. double superphosphate and 200 lb. of sulphate of ammonia	1,736	517
Above plus 268 lb. gypsum	1,707	488

In the Eastern, Northern and Tanga Provinces a number of trials were laid down to find the best methods of growing cotton generally.

TABLE 31

SHOWING RESULTS OBTAINED ON METHODS OF GROWING COTTON, EASTERN AND TANGA PROVINCES, LB. OF SEED COTTON PER ACRE

Planting Time		Yield	Spacing	Yield
February	...	820	3 ft. × 1 ft. 1 plant per hole	816.
March	...	680	3 ft. × 3 ft. 2 plants per hole	685.
Spraying	...	1,033		
Dusting	...	736		
Control	...	489		

The results obtained from these district plots were in agreement with expectation, early planting with a high plant population and insect control are important factors in producing high yields.

Two similar trials in the Northern Province were irrigated. At one site, Mbuguni, a very heavy infestation of red spider mite occurred, following routine insecticide applications, after flowering and the results obtained were unreliable. At Moshi the results were excellent, an average yield of 2,745 lb. per acre being recorded.

Cotton was tried as a possible cash crop at two of the trial farms run by the Tanganyika Agricultural Corporation in the Rufiji Basin. Comparisons were made of dates of planting, varieties and insecticide use. At Lumemo, Kilombero valley, the water table was high and the best yields were 1,600 lb. of seed cotton per acre. At Mbarali, Bohoro flats, yields from some plots were equivalent to 3,000 lb. per acre. At both these sites the standard routine spraying was effective against heavy bollworm and stainer attacks. Dusting was not effective at Mbarali due to constant high winds. The Sudan varieties proved to be unsuitable at Lumemo.

In Tanga Province five varieties of cotton were grown in observation plots at eight sites. Three UK. varieties 51, 48 and 46 were compared with 0/334 and BP 52. The UK. varieties generally outyielded the others.

Breeding and Selection.

At Ukiriguru there are three breeding programmes. One is the testing of straight Ukiriguru selections, the other two are concerned with improving the resistance of UK. strains to the several manifestations of bacterial blight, *Xanthomonas malvacearum*. It had been thought that at this stage in the Albar 51 programme the straight Ukiriguru strains might be discarded but it is clear that in selecting for yield and discarding for "scruffiness" a somewhat higher degree of resistance to bacterial blight has been achieved than was anticipated. Thus the UK. 55 strains tested on district plots showed yields comparable with trial of the Albar 51 strains.

The relationship between earliness and yield was again studied over the range of material. Most of the later strains fell into the higher yielding classes but the relationship was by no means clear cut and a proportion of the earlier strains were also among the higher yielders. A drought and an associated build up of aphids occurred in February. There was noticeable segregation amongst the Albar strains in their ability to withstand and recover from these conditions.

The programme involving the addition of the resistant gene B 6 M to Ukiriguru strains was continued. It is doubtful if this material will have any advantages over the other resistant stocks being tested.

At Ilonga the breeding work is developing along three main lines:
Testing of selections and reselections from local stock;
The use of progeny rows and the selection index technique;
Panmixis bulks for rain grown and irrigated types.

A further 1,400 single plant selections were made this season and of these 330 will be planted next year, the remainder having proved unsatisfactory in one character or another. From the three strain trials 48 strains have been kept for further study. These show generally a higher resistance to jassid, ginning out-turn and of course good yielding characteristics.

Lint quality appears to be satisfactory in the selections being made but yarn appearance must be watched as the greater length, strength and fineness of the variety IL. 58 appears to be associated with an increased tendency to neppiness.

Plant Protection.

Attention was given at Ukiriguru this season to the possibilities of improving the efficiency of seed treatment under commercial conditions. As a result of tests last season and further tests using the Booth drum, recommendations were made that the rate of Perecot application be increased from 1: 250 w/w to 1: 200 w/w and that the charging rate for the 35 cu. feet drum be reduced from 10 cwt. to 8 cwt. in order to achieve a more uniform coverage of seed. Both these recommendations have been put into effect.

In addition experiments were carried out on the use of mercurial formulations under commercial conditions. Fifty tons of UK. 55 have been treated with Abavit B. and it will be possible to make some assessment of the control of bacterial blight achieved during the coming season.

In an experiment to check the importance of cotton trash for the carry over of bacterial blight in the field, weathered trash and trash stored in bags until cultivation were tested using normal local cultivation practices i.e. placing weeds and plant debris in the previous years furrows and splitting the old ridges over the furrow. No infection attributable to the trash could be detected.

The wilt (*Fusarium oxysporum* f. *vasinfectum*) has been found in several more localities but it is doubtful to what extent this represents spread of disease since some discoveries were in areas not previously examined. No outbreaks have been confirmed in inland areas and the disease seems to be associated with one particular soil type occurring round the Lake fringe.

As a precaution against the possibility that wilt might become more widespread a start was made on testing resistant varieties. Introduced varieties are not promising for this, but a few healthy plants persisted until the end of the season on infested sites. This suggests the possibility of resistance being present in local strains. It might be possible to select out resistant strains from local stock.

With the appointment of an entomologist to Ukiriguru an investigation has begun on the bionomics of American bollworm locally. Early in the season larvæ were found in small numbers on a wide range of crops but from April onwards the attack seemed to be confined sclely to cotton. In February a localized attack had to be controlled. The last *Heliothis* larvæ were collected in the field from cotton in early July. A single moth was taken in a light trap on August 22nd and two more were taken on December 8th.

In a spraying trial comparing eight weekly applications of:

(a) Didimac 25 and Gamalin 20 costing Shs. 161 per acre.

(b) Didigam A costing Shs. 192 per acre,

yields were increased and the proportion of grade C cotton reduced. Expenditure on insecticide was high and resultant profits low, Shs. 99 for treatment A and Shs. 21 for treatment B.

Spiny bollworms were present throughout Lake Province. There was a build up in April in Geita District which destroyed a large part of the top crop. In July it was the most important pest found at Missenyi, Bukoba. As this pest did not become important until spraying programmes were finished and as by its habit it is inconspicuous, its importance tends to be under-estimated.

At Ilonga the American bollworm attack followed its usual pattern and spiny bollworm was common from June onwards on the top crop of plants inadequately protected from pests. A devastating attack by *Helopeltis* sp. was observed in an area adjacent to the Research Centre. The plants were so distorted that no fruit at all was produced. Red spider mite was observed again on experimental cotton but it is not considered that the infestation had any marked effect on yield. A very large number of crop, weed and bush plants have been recorded as host plants, providing a very effective carry-over of the mite from one growing season to the next.

Two insecticide formulations were compared with the recommended "Cotton Dust" containing 10 per cent DDT. and 3 per cent gamma B.H.C., Table in single and double rows of the same population. Double rows were tested to open up the crop for easier access.

TABLE 32

SHOWING THE EFFECT OF SINGLE AND DOUBLE ROWS ON YIELD USING THREE INSECTICIDAL DUST FORMULATIONS IN LB. OF SEED COTTON AND CASH VALUES PER ACRE

Treatment	*Spacing*	*Yield*	*Cost* Shs.	*Value* Shs.
1 lb. DDT. + 0·3 lb. B.H.C.	Single ...	1,278 ...	62 ...	552
1 lb. DDT. + 0·3 lb. B.H.C.	Double ...	1,205 ...	62 ...	520
1 lb. DDT. + 0·3 lb. gamma B.H.C. ...	Single ...	1,262 ...	88 ...	512
1 lb. DDT. + 0·3 lb. gamma B.H.C. ...	Double ...	1,315 ...	88 ...	523
1 lb. DDT. + 0·1 lb. Malathion	Single ...	1,437 ...	90 ...	608
1 lb. DDT. + 0·1 lb. Malathion	Double ...	1,428 ...	90 ...	603

The treatments were applied eight times.

Yields were similar for both single and double rows but the double row made for easier operation both for dusting and harvesting.

The two formulations based on DDT. and B.H.C. gave similar yields but that containing gamma B.H.C. was appreciably more expensive. Although the DDT. plus Malathion was the most expensive formulation used the extra return obtained justified its use. Its advantage seemed to be that it gave additional control of bollworms as well as checking aphid build up.

In another experiment Endrin at ¼ lb. per acre per spraying gave a similar yield to that obtained by DDT. plus B.H.C. but was appreciably cheaper, about Shs. 50 per acre. Pyrethrum sprays were also tested and whilst they restricted jassid breeding there was no discernible effect on bollworms. Since DDT. is effective against jassid the addition of pyrethrins does not seem to be warranted.

It is well known that cotton is capable of compensating for loss of fruits early in its development. A trial was conducted to see whether postponing spraying for 1, 2, 3 and 4 weeks after the beginning of the bollworm attack would cause any reduction in yield. Postponing spraying caused an increase in loss of fruit but there was only a slight reduction in the number of bolls saleable per plant, from 46 to 42, unsprayed plants having 14. There was however a very great reduction in quality. 93 per cent clean cotton was obtained if spraying was delayed one week, and 62 per cent for a four-week delay. Thus the saving in cost of insecticide resulted in a greater loss from lower quality.

Dusting trials were successfully carried out on 37 African plots in Tanga Province, Pare District, where the cultivation standards were good. Appreciable and profitable gains were recorded on the average and only five plots failed to show a profit.

YIELD PER ACRE, LB. SEED COTTON

	A.R.	B.R.	Total
Undusted	332 ...	186 ...	518
Dusted	845 ...	121 ...	966

Taking the cost of dusting as Shs. 100 per acre, this represents an average profit of Shs. 160 per acre.

Even more striking effects were shown in the Northern Province, Mbulu District.

	A.R.	B.R.	Total
Undusted	344 ...	144 ...	488
Dusted	1,000 ...	168 ...	1,168

Widespread trials were carried out in the Lake Province, North Mara, Musoma, Geita South, Biharamulo and Shinyanga districts. Appreciable increases in yield were recorded from North Mara and South Geita, 250-550 lb. per acre. Responses were poor at Musoma, Suguti area, where damage is usually heavy. This year insect damage was negligible as the cotton was planted early and maize planted late.